CHEMICAL ENGINEERING, BS

Chemical engineers exploit advances in chemistry and biology to create new products, design chemical processes, develop energy resources, and protect the environment. Students receive a thorough grounding in chemistry, biology, mathematics and physics. With this broad scientific training, chemical engineers work effectively on a diverse set of problems involving chemical, physical, and biological phenomena. For example, chemical engineers develop environmentally benign and safe processes to make the chemical products that people depend on. They work in research and development laboratories, creating polymeric materials with improved performance and durability. They work in manufacturing, making vaccines and antibiotics. They invent new ways to keep our food and water supplies safe. Opportunities for chemical engineers span numerous industries: pharmaceuticals, polymers, energy, food, consumer products, biotechnology, and electronic and optical materials. Graduates understand the needs of society, and use their training in science and technology to meet those needs.

The chemical engineering program develops the student's capability for invention and analysis of chemical processes and products. Students in the program take several classes in chemistry, along with courses in physics, mathematics, and biology. The curriculum provides a rigorous education in the fundamental chemical engineering sciences of thermodynamics, transport phenomena, and kinetics, as well as more applied areas such as materials science, biochemical engineering, or chemical process design. Because engineers must be skilled communicators, the curriculum places considerable emphasis on technical report writing, team projects, and formal and informal oral presentation. In addition, students broaden their understanding of people and society by taking several courses in the humanities and social sciences.

The BS program in chemical engineering leads to a wide variety of careers. Graduates are prepared for professional lives in industry, government, engineering design, or consulting companies. Graduates with a more practical, hands-on approach are employed in manufacturing support, process development, product development, design, construction, or technical sales. They rapidly advance to responsible technical supervisory and management positions. Graduates with a research interest work to improve understanding of scientific engineering principles, and to apply these principles to solve emerging problems. Entrepreneurial graduates work in smaller enterprises, or create their own businesses, developing the major industries of tomorrow. An undergraduate degree in chemical engineering provides a strong basis for advanced study in graduate school, or for further training in medicine, law, or policy.

HOW TO GET IN

HOW TO GET IN

ADMISSION TO THE COLLEGE AS A FIRST-YEAR STUDENT

Students applying to UW–Madison (https://www.admissions.wisc.edu/apply/) need to indicate an engineering major (https://engineering.wisc.edu/degrees-programs/undergraduate/) as their first choice in order to be considered for direct admission to the College of Engineering. Being directly admitted to a major means students will start in the program of their choice in the College of Engineering and will need to meet progression requirements (https://engineering.wisc.edu/student-services/undergraduate-student-advising/progression/) at the end of the first year to guarantee advancement in that program.

CROSS-CAMPUS TRANSFER TO ENGINEERING

UW–Madison students in other schools and colleges on campus must meet minimum admission requirements (https://engineering.wisc.edu/admissions/undergraduate/cross-campus-students/) for admission consideration to engineering degree programs. Cross-campus admission is competitive and selective, and the grade point average expectations may increase as demand trends change. The student's overall academic record at UW–Madison is also considered. Students apply to their intended engineering program by submitting the online application by stated deadlines for spring and fall. The College of Engineering offers an online information tutorial and drop-in advising (https://engineering.wisc.edu/admissions/undergraduate/cross-campus-students/) for students to learn about the cross-campus transfer process.

OFF-CAMPUS TRANSFER TO ENGINEERING

With careful planning, students at other accredited institutions can transfer coursework that will apply toward engineering degree requirements at UW–Madison. Off-campus transfer applicants are considered for direct admission to the College of Engineering by applying to the Office of Admissions with an engineering major listed as their first choice. Those who are admitted to their intended engineering program must meet progression requirements (https://engineering.wisc.edu/admissions/undergraduate/transfer-from-off-campus/) at the point of transfer or within their first two semesters at UW–Madison to guarantee advancement in that program. A minimum of 30 credits in residence in the College of Engineering is required after transferring, and all students must meet all requirements for their major in the college. Transfer admission to the College of Engineering is competitive and selective, and students who have exceeded the 80 credit limit at the time of application are not eligible to apply.

The College of Engineering has dual degree programs with select four-year UW System campuses. Eligible dual degree applicants are not subject to the 80 credit limit.

Off-campus transfer students are encouraged to discuss their interests, academic background, and admission options with the Transfer & Academic Program Manager in the College of Engineering: ugtransfer@engr.wisc.edu or 608-262-2473.

SECOND BACHELOR'S DEGREE

The College of Engineering does not accept second undergraduate degree applications. Second degree student (https://engineering.wisc.edu/admissions/undergraduate/adult-students-second-degree-students/)s (https://engineering.wisc.edu/student-services/undergraduate-student-advising/) might explore the Biological Systems Engineering program at UW–Madison, an undergraduate engineering degree elsewhere, or a graduate program in the College of Engineering.

REQUIREMENTS

REQUIREMENTS

UNIVERSITY GENERAL EDUCATION REQUIREMENTS

All undergraduate students at the University of Wisconsin–Madison are required to fulfill a minimum set of common university general education requirements to ensure that every graduate acquires the essential core of an undergraduate education. This core establishes a foundation for living a productive life, being a citizen of the world, appreciating aesthetic values, and engaging in lifelong learning in a continually changing world. Various schools and colleges will have requirements in addition to the requirements listed below. Consult your advisor for assistance, as needed. For additional information, see the university Undergraduate General Education Requirements (http://guide.wisc.edu/undergraduate/#requirementsforundergraduatestudytext) section of the *Guide*.

General Education
- Breadth—Humanities/Literature/Arts: 6 credits
- Breadth—Natural Science: 4 to 6 credits, consisting of one 4- or 5-credit course with a laboratory component; or two courses providing a total of 6 credits
- Breadth—Social Studies: 3 credits
- Communication Part A & Part B *
- Ethnic Studies *
- Quantitative Reasoning Part A & Part B *

* The mortarboard symbol appears before the title of any course that fulfills one of the Communication Part A or Part B, Ethnic Studies, or Quantitative Reasoning Part A or Part B requirements.

SUMMARY OF REQUIREMENTS

The following curriculum applies to students admitted to the chemical engineering degree program.

Code	Title	Credits
Mathematics		19
Physics		10
Chemistry		20
Life Science		6
Core Engineering Requirement		49
Professional Breadth		6
Communication Skills		6
Liberal Studies Requirement		16
Total Credits		**132**

MATHEMATICS REQUIREMENT

The calculus requirement must be met with a minimum of 12 credits to cover the three-course basic math sequence. Any deficiency in total math credits must be made up with electives in science or engineering.

Code	Title	Credits
MATH 221	Calculus and Analytic Geometry 1	5
or MATH 217	Calculus with Algebra and Trigonometry II	
MATH 222	Calculus and Analytic Geometry 2	4
MATH 234	Calculus--Functions of Several Variables	4
MATH 320	Linear Algebra and Differential Equations	3
or MATH 319	Techniques in Ordinary Differential Equations	
STAT 324	Introductory Applied Statistics for Engineers	3
Total Credits		**19**

PHYSICS REQUIREMENT

Credit shortages caused by transfer physics courses at fewer than 6 credits for the required courses must be made up with another physics course.

Code	Title	Credits
PHYSICS 201	General Physics	5
or PHYSICS 207	General Physics	
PHYSICS 202	General Physics	5
or PHYSICS 208	General Physics	
Total Credits		**10**

CHEMISTRY REQUIREMENT

Credit shortages cause by transfer of freshman chemistry courses at fewer than 9 credits must be made up with chemistry, biochemistry, or chemical engineering courses.

Code	Title	Credits
General Chemistry (choose one)		*5-9*
CHEM 109	Advanced General Chemistry (preferred)	
CHEM 103 & CHEM 104	General Chemistry I and General Chemistry II	
CHEM 329	Fundamentals of Analytical Science	4
CHEM 343 & CHEM 345 & CHEM 344	Organic Chemistry I and Organic Chemistry II and Introductory Organic Chemistry Laboratory	8
CHEM 562	Physical Chemistry II	3
Total Credits		**20-24**

LIFE SCIENCE

Students who meet the Introductory Biology requirement with an AP exam are encouraged to take two advanced biology electives.[1]

Code	Title	Credits
Introductory Biology requirement (choose one)		*3*
PL PATH 375	Special Topics (Topic: Intro Biology for Engineers)	
ZOOLOGY 153	Introductory Biology	
ZOOLOGY/ BIOLOGY/ BOTANY 151	Introductory Biology	
Advanced Biology requirement (choose one)		*3*
BIOCHEM 501	Introduction to Biochemistry	
BIOCHEM 507	General Biochemistry I	
ZOOLOGY 570	Cell Biology	

GENETICS 466	Principles of Genetics	
MICROBIO 303	Biology of Microorganisms	
Total Credits		**6**

[1] BIOCORE 381 Evolution, Ecology, and Genetics and BIOCORE 383 Cellular Biology may be used to satisfy the Life Sciences Requirements.

CORE ENGINEERING REQUIREMENT

Code	Title	Credits
CBE 150	Introduction to Chemical Engineering	1
CBE 250	Process Synthesis (with a grade of C or better)	3
CBE 255	Introduction to Chemical Process Modeling	3
CBE 310	Chemical Process Thermodynamics (with a grade of C or better)	3
CBE 311	Thermodynamics of Mixtures (with a grade of C or better)	3
CBE 320	Introductory Transport Phenomena (with a grade of C or better)	4
CBE 324	Transport Phenomena Lab	3
CBE 326	Momentum and Heat Transfer Operations	3
CBE 424	Operations and Process Laboratory	5
CBE 426	Mass Transfer Operations	3
CBE 430	Chemical Kinetics and Reactor Design	3
Select one of the following:		*3*
CBE 440	Chemical Engineering Materials	
CBE 540	Polymer Science and Technology	
CBE 547	Introduction to Colloid and Interface Science	
CBE 450	Process Design	3
CBE 470	Process Dynamics and Control	3
CBE Electives [2]		6
Total Credits		**49**

[2] Chemical Engineering electives may be chosen from any of the CBE courses that are not required, numbered 300 or above (excluding seminar courses). A maximum of two credits of co-op work (CBE 1 Cooperative Education Program) may be used to meet the CBE elective requirement. Qualified undergraduates may take graduate-level (600 or 700) courses to fulfill this requirement.

PROFESSIONAL BREADTH

Select 6 credits

Code	Title	Credits
Professional Breadth Credits [3]		**6**
Courses 300+ from the following College of Engineering departments and programs may be used:		
Biomedical Engineering		
Civil and Environmental Engineering		
Electrical and Computer Engineering		
Engineering Mechanics and Astronautics		
Engineering Professional Development		
Geological Engineering		
Industrial Engineering		
Interdisciplinary Courses (Engineering)		
Materials Science and Engineering [4]		
Mechanical Engineering		
Nuclear Engineering		
Engineering Physics		
Courses 300+ from the following departments in the College of Letters and Sciences may be used:		
Chemistry		
Computer Sciences		
Math		
Physics		
The following courses may also be used:		
ACCT I S 300	Accounting Principles	
BIOCHEM 501	Introduction to Biochemistry	
BIOCHEM 507	General Biochemistry I	
BIOCORE 381	Evolution, Ecology, and Genetics	
BIOCORE 383	Cellular Biology	
BSE 364	Engineering Properties of Food and Biological Materials	
BSE/ ENVIR ST 367	Renewable Energy Systems	
ECON/A A E/ ENVIR ST 343	Environmental Economics	
ENVIR ST/ GEOSCI 411	Energy Resources	
ENVIR ST/ PHILOS 441	Environmental Ethics	
FINANCE/ ECON 300	Introduction to Finance	
FOOD SCI 550	Fermented Foods and Beverages	
GEN BUS 310	Fundamentals of Accounting and Finance for Non-Business Majors	
GEN BUS 311	Fundamentals of Management and Marketing for Non-Business Majors	
GENETICS 466	Principles of Genetics	
M H R 300	Managing Organizations	
MICROBIO 303	Biology of Microorganisms	
STAT/M E 424	Statistical Experimental Design	
ZOOLOGY 570	Cell Biology	
Total Credits		**6**

Students may petition the department to allow other courses related to engineering professional practice. To request that a course not listed above be used, the student should fill out the Professional Breadth Requirement Course Request form available online and submit it to the advisor. The department will then determine if the course can be counted toward the Professional Breadth Requirement. Petitions must be submitted before the beginning of the semester in which the course is to be taken.

[3] The objective of this requirement is to provide students with skills to interact with professionals from other disciplines. Suitable courses for

this requirement include courses in engineering (excluding CBE) and science, as well as a variety of other disciplines.

[4] Full degree credit is not allowed if a student takes both CBE 440 Chemical Engineering Materials and M S & E 350 Introduction to Materials Science. In this case M S & E 350 Introduction to Materials Science will be awarded only 1 degree credit.

COMMUNICATION SKILLS

Code	Title	Credits
ENGL 100	Introduction to College Composition [5]	3
or COM ARTS 100	Introduction to Speech Composition	
or LSC 100	Science and Storytelling	
or ESL 118	Academic Writing II	
INTEREGR 397	Engineering Communication	3

[5] For Part A of the General Education Communication Requirement (3 cr) students must select one course with an "a" designation in "g" of the "geBLC" information in the Course Guide. Some students will be exempt from this requirement based on their placement test scores or advanced placement in English.
CBE 424 Operations and Process Laboratory satisfies Part B of the General Education Communication Skills Requirement.

LIBERAL STUDIES ELECTIVES

Students must complete 16 credits of liberal studies according to the College of Engineering requirements.

1. Liberal studies elective courses must be classified as either Humanities, Social Studies, or Literature courses (identified by the letters H, S, L, or Z in "B" of the "geBLC" information in the Guide). At least six credits must have a breadth designation of Humanities (H, L, or Z), and at least three credits must have a designation of Social Studies (S or Z). Foreign language courses count as H credits.
2. A three-credit ethnic studies course must be selected from the College of Letters & Science. Acceptable courses are identified by the letter "e" in Guide. If appropriate, the ethnic studies course may be among those used to satisfy the concentration requirement.
3. A minimum of two liberal studies courses must be taken from the same subject area (https://registrar.wisc.edu/subjectareas/) (the description before the course number). At least one of these two courses must be at an intermediate or advanced level (designated in Guide).
4. Retroactive credits (retrocredits) may be awarded for world languages work done in high school. Criteria for awarding retrocredits is described in the L&S policy section of GUIDE (https://guide.wisc.edu/undergraduate/letters-science/#Credit-by-exam-retrocredits).
   a. Retrocredits do not count toward the 16 liberal-studies credits required.
   b. Retrocredits may be used to satisfy the concentration and depth requirements as stated in number three above and count as degree credits.
5. English composition courses, English as a Second Language courses, and basic communications arts courses are not accepted as liberal studies electives.

FREE ELECTIVES

Students fulfilling their course requirements with fewer than 132 credits must take additional free-elective credits to comply with the 132-credit minimum graduation requirement.

COURSE SUBSTITUTION REGULATIONS

1. Any student may, with advisor approval, replace up to 12 credits of required courses in the curriculum, except CBE 424 Operations and Process Laboratory, by an equal number of credits of other courses within the limitations listed under (3) below.
2. Any student who wishes to amend the curriculum by more than 12 credits or wishes to appeal the advisor's decision in (1) or to request exception to (3) below must submit a written request to the chair of the department, who will bring it to the department faculty for consideration.
3. Restrictions on course substitutions are as follows:
   a. Physics courses may be replaced by science or engineering courses.
   b. Chemistry/life science courses must be replaced by courses with significant chemistry/life science content.
   c. Engineering courses must be replaced by engineering courses.
   d. Lab courses must be replaced by courses with an equal number of hours of lab courses.
   e. English as a Second Language courses, and MATH 112 Algebra, MATH 113 Trigonometry, and MATH 114 Algebra and Trigonometry may not be used for course substitutions.

HONORS IN UNDERGRADUATE RESEARCH PROGRAM

The Honors in Research program in Chemical Engineering is designed for students who wish to have a more in-depth research experience and is particularly recommended for students considering enrollment in a PhD program. To be accepted into the Honors in Research program, students must have completed at least two semesters on the UW-Madison campus with a cumulative GPA of at least 3.5 and should find a faculty mentor. Students register for 1-3 credits of CBE 489 Honors in Research and are expected to complete at least 8 credits of CBE 489 over 2-3 semesters. Students must also write a senior thesis and present the work to a committee of faculty. Students meeting all requirements, and maintaining a cumulative GPA of at least 3.3, will receive the Honors in Research designation upon graduation.

UNIVERSITY DEGREE REQUIREMENTS

Total Degree	To receive a bachelor's degree from UW–Madison, students must earn a minimum of 120 degree credits. The requirements for some programs may exceed 120 degree credits. Students should consult with their college or department advisor for information on specific credit requirements.
Residency	Degree candidates are required to earn a minimum of 30 credits in residence at UW–Madison. "In residence" means on the UW–Madison campus with an undergraduate degree classification. “In residence” credit also includes UW–Madison courses offered in distance or online formats and credits earned in UW–Madison Study Abroad/Study Away programs.

Quality of Work	Undergraduate students must maintain the minimum grade point average specified by the school, college, or academic program to remain in good academic standing. Students whose academic performance drops below these minimum thresholds will be placed on academic probation.

LEARNING OUTCOMES

LEARNING OUTCOMES

1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
3. an ability to communicate effectively with a range of audiences
4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies

FOUR-YEAR PLAN

FOUR-YEAR PLAN

SAMPLE FOUR-YEAR PLAN

First Year

Fall	Credits	Spring	Credits
CHEM 109	5	CHEM 329	4
MATH 221	5	MATH 222	4
CBE 150	1	PHYSICS 201	5
Communications A	3	Liberal Studies Elective	3
Liberal Studies Elective	3		
	17		**16**

Second Year

Fall	Credits	Spring	Credits
CBE 250[1]	3	CBE 255	3
CHEM 343[2]	3	MATH 320 or 319	3
MATH 234	4	CBE 310[1]	3
PHYSICS 202	5	CHEM 345 & CHEM 344	5
ZOOLOGY 153	3	STAT 324	3
	18		**17**

Third Year

Fall	Credits	Spring	Credits
CBE 311[1]	3	CBE 326	3
CBE 320[1]	4	CBE 324	3
Professional Breadth Elective	3	CHEM 562	3
Advanced Biology Elective	3	INTEREGR 397	3
Liberal Studies Elective	3	Liberal Studies Elective	4
	16		**16**

Fourth Year

Fall	Credits	Spring	Credits	Summer	Credits
CBE 426	3	CBE 450	3	CBE 424	5
CBE 430	3	CBE 470	3		
CBE Elective	3	CBE Elective	3		
Materials Elective	3	Professional Breadth Elective	3		
Liberal Studies Elective	3				
	15		**12**		**5**

Total Credits 132

1 CBE 250 Process Synthesis and CBE 320 Introductory Transport Phenomena, CBE 310 Chemical Process Thermodynamics, and CBE 311 Thermodynamics of Mixtures require a grade of C or better.

2 CHEM 343 Organic Chemistry I requires a grade of C or better.

ADVISING AND CAREERS

ADVISING AND CAREERS

ADVISING

Every College of Engineering undergraduate has an assigned academic advisor (https://engineering.wisc.edu/student-services/undergraduate-student-advising/). Academic advisors support and coach students through their transition to college and their academic program all the way through graduation.

Advisors help students navigate the highly structured engineering curricula and course sequencing, working with them to select courses each semester.

When facing a challenge or making a plan toward a goal, students can start with their academic advisor. There are many outstanding resources at UW–Madison, and academic advisors are trained to help students navigate these resources. Advisors not only inform students about the various resources, but they help reduce the barriers between students and campus resources to help students feel empowered to pursue their goals and communicate their needs.

Students can find their assigned advisor in their MyUW Student Center.

ENGINEERING CAREER SERVICES

Engineering Career Services (https://ecs.wisc.edu) (ECS) assists students in finding work-based learning experiences such as co-ops and

summer internships, exploring and applying to graduate or professional school, and finding full-time professional employment.

ECS offers two large career fairs per year, assists students with resume building and developing interviewing skills, hosts skill-building workshops, and meets one-on-one with students to discuss offer negotiations.

Students are encouraged to engage with the ECS office early in their academic careers. For more information on ECS programs and workshops, visit: https://ecs.wisc.edu.

PEOPLE

PEOPLE

PROFESSORS

Brian F. Pfleger (Chair)
Michael David Graham
George Huber
Daniel J. Klingenberg
David M. Lynn
Manos Mavrikakis
Sean P. Palacek
Thatcher Root
Eric V. Shusta
John Yin
Victor Zavala

ASSOCIATE PROFESSORS

Reid Van Lehn
Ross E. Swaney

ASSISTANT PROFESSORS

Styliani Avraamidou
Rose Cersonsky
Quentin Dudley
Matthew Gebbie
Siddarth Krishna
Whitney Loo
Mai Ngo
Marcel Schreier

TEACHING FACULTY

Brendan Blackwell
Eric Codner
Kate Dahlke
Andrew Greenberg

PROFESSOR OF PRACTICE

William Banholzer

See also Chemical and Biological Engineering Faculty Directory (https://directory.engr.wisc.edu/che/faculty/).

ACCREDITATION

ACCREDITATION

Accredited by the Engineering Accreditation Commission ofABET, https://www.abet.org, under the commission's General Criteria and Program Criteria for Chemical, Biochemical, Biomolecular, and Similarly Named Engineering Programs.

PROGRAM EDUCATIONAL OBJECTIVES FOR THE BACHELOR OF SCIENCE IN CHEMICAL ENGINEERING

We recognize that our graduates will choose to use the knowledge and skills that they have acquired during their undergraduate years to pursue a wide variety of career and life goals, and we encourage this diversity of paths.Whatever path our graduates may choose, we expect them to be meeting the following objectives at least three to five years after graduation:

1. exhibit strong skills in problem solving, leadership, teamwork, and communication;
2. use these skills to contribute to the various communities, both local and global, within which they work, live, and function;
3. make thoughtful, well-informed career choices; and
4. demonstrate a continuing commitment to and interest in education (their own and others')

Note: Undergraduate Student Outcomes, number of degrees conferred, and enrollment data are made publicly available at the Chemical Engineering Undergraduate Program website. (In this Guide, the program's Student Outcomes are available through the "Learning Outcomes" tab.)